U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 65.

Experiment Station Work—II.

COMMON CROPS FOR FORAGE.
STOCK MELONS.
STARCH IN POTATOES.
CRIMSON CLOVER.
GEESE FOR PROFIT.
CROSS POLLINATION.
A GERM FERTILIZER.
LIME AS A FERTILIZER.
ARE ASHES ECONOMICAL?
MIXING FERTILIZERS.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., November 15, 1897.

SIR: The second number of Experiment Station Work, prepared under my direction, is transmitted herewith with the recommendation that it be published as a Farmers' Bulletin.

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

EXPERIMENT STATION WORK—II.[1]

THE VALUE OF COMMON CROPS FOR FORAGE.

The failure of pastures to furnish sufficient nutritive forage throughout the season has been a powerful incentive to the production of forage crops. The droughts experienced in various sections of the country during recent years have been especially harmful in reducing pasturage, and although forage crops have not yielded abundantly during these times they have been a great help in bringing stock through the periods of scarcity wherever they were grown. Even under favorable conditions pasture grass is likely to get "hard" and unpalatable to stock as the season advances, and in such cases also forage crops prove themselves to be very advantageous.

A valuable bulletin giving the results of experiments with forage crops has recently been issued by the New York Cornell Station. An especially valuable feature of these experiments is that they were made with corn, oats, peas, barley, rye, and millets—crops with which every one is familiar and which can be grown almost everywhere in the country. Among the newer forage crops to which the experiment stations have turned their attention there are probably many which will prove valuable in one section or another, but they are as yet not so well known as our common crops and farmers are not so familiar with their culture and use. The experiments at the Cornell Station were made to determine the relative feeding value of the several crops grown in different ways and harvested at different periods.

[1] This is the second number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director Office of Experiment Stations.

CORN.

"The most valuable crop for the production of late forage is corn," and for this reason corn was given particular attention in these Cornell experiments. In 1895 and 1896 corn was grown in hills, drills, and broadcast. The following table shows the average for the two years:

Average yield per acre of the different plats.

Manner of planting.	Stalks.	Grain.	Total.
	Pounds.	*Pounds.*	*Pounds.*
Hills	17,070	5,640	22,710
Drills	19,815	4,352	24,167
Broadcast	29,585	....	29,585

"If the investigations had stopped here the results would clearly have been in favor of the broadcast method of seeding. This is as far as the producer is able to go, unless he is of an especially inquiring mind and conducts careful feeding experiments with an endeavor to find out from the animal which material is best." An analysis of the crop of 1895 was made when the crop was in best condition for forage, and with this analysis as a basis the amounts of the various food constituents—protein, fat, nitrogen-free extract and fiber—for the average yield of the different plats were determined. The percentage of each food constituent was smallest in the corn which had been sown broadcast and greatest in the corn grown in hills, with the exception that the drilled corn contained slightly the highest percentage of fiber, which is the least valuable constituent. Although the corn grown in hills produced the smallest weight of crop, it yielded the largest amount of food constituents and ranked first in feeding value. The plat of broadcast corn produced no grain but gave the largest total yield, and although containing smaller percentages of the various food constituents, its absolute feeding value was somewhat greater than that of the drilled corn.

A serious objection to sowing corn is that sowed corn is quickly affected by drought. The available moisture of the soil is entirely inadequate to supply the demands of the growing crop when so thickly planted. Moreover, "corn is a sun plant and grows to perfection only when the sunlight permeates to every part of its structure. * * * Could the animal have been questioned as to which method of planting furnished the best fodder, she would have spoken in unmistakable terms in favor of that corn which was grown in the open sunlight," i. e., in hills.

To determine the best period for cutting corn, analyses were made at five different dates, the first August 2 and the last September 24.

The results [of these experiments as well as of similar ones at other stations] unite to show that there is a large increase of all the classes of nutrients as the corn

proceeds from tasseling to ripeness. * * * An increase of more than 200 per cent between the periods of blooming and ripening can not be ignored even though the proportion of the more valuable albuminoids is somewhat lessened.

In other words the corn should not be cut until it has reached maturity. It is common to assume that this point has been practically reached when the kernels begin to glaze. The facts obtained from these experiments are applicable to corn as a silage crop as well as a forage crop.

OATS AND PEAS, BARLEY AND PEAS, AND RYE.

While corn ranked first for forage, a mixed crop of oats and Canadian field peas stood a close second, and is "well worthy of a place on every farm where stock is kept." Such a mixed crop is recommended as being valuable for pasture, for cutting as a soiling crop, and, when mature, for hay. "When planted in succession of about 2 weeks, the first planting being as early in the spring as conditions will permit, a succession of highly nutritious forage is produced which is greatly relished by stock."

The following directions for growing the crop are given:

This crop loves a mellow, loamy soil, but will grow fairly well on soils ranging between heavy clay and sand and produce liberal returns. For early forage land should be selected which is moderately open and porous, so that the plowing may be done early. Those soils containing a comparatively large percentage of clay can better be used where late forage is desired. Land should be plowed deep, and in cases where sod is inverted the jointer should be used. While the land is still rough, as left by the plow, the peas should be sown broadcast at the rate of about 1 bushel per acre. Then the harrow should be used and the land thoroughly fitted and fined for oats. This fitting will cover the peas deeply and well, and it is to secure this deep covering that the peas are sown directly after the plow. Oats may then be sown broadcast or drilled in the ordinary way, using 1 bushel to 1½ bushels of seed per acre. If the soil is somewhat porous, sandy or gravelly, the roller may follow the seeding. But should there be a somewhat large percentage of clay in the soil then the rolling would better be deferred until the young plants are 2 or 3 inches high, when the roller can be used without danger of producing injurious soil conditions due to packing.

Comparative tests were made during 1895 and 1896 of oats and peas, oats, barley and oats, and barley. The average yields were nearly 12, 8, 7.5, and 6.5 tons per acre, respectively. The estimated value of the food constituents per acre, calculated on the dry matter, is given as \$63.11 for oats and peas, \$57.99 for oats alone, \$43.39 for oats and barley, and \$31.99 for barley alone. "Though the estimated values given do not necessarily represent the actual feeding value, yet they do fairly show the relative value of the different crops for the production of forage." The most valuable constituent of a fodder is protein, in which oats and peas are relatively rich.

Barley and peas are recommended in preference to oats and peas for late forage, as barley grows much faster and is less subject to rust and drought than oats.

"Rye as a forage crop has to recommend it the fact that it is available for early spring use. As a cover crop it is becoming more general, and for this purpose it is valuable."

HUNGARIAN GRASS AND MILLETS.

Hungarian grass sown on June 29 yielded 5½ tons of green forage per acre when cut August 11. The value and uses of Hungarian grass and millets are imperfectly understood, and the serious results that have followed heavy feeding with these plants tend to discourage their production. "Animals not accustomed to green forage should not at first be allowed a full feed of any green crop, especially millet, but should be given only a part ration of the green material. * * * Millets are valuable, and when fed properly may be used without danger." The authors recommend that some other coarse fodder be used with the millet hay when the latter is fed to horses.[1] "Much of the value of millet hay seems to depend on the time of cutting, which should be soon after blossoming."

STOCK MELONS.

During the last few years the Kansas and Oklahoma Experiment Stations have experimented to some extent with stock melons, or as they are sometimes called pie melons, or citrons. This melon, which is regarded as a nonsaccharine watermelon, or a cross between citron melon and watermelon, grows readily and gives a large crop, the fruits weighing 20 pounds or more each. The fruit has somewhat the appearance of a watermelon. The flesh is solid and lacks sweetness.

Stock melons may be planted with corn, the same as pumpkins, or grown by themselves. They require somewhat the same soil and treatment as watermelons. It has been found in California that they produce an abundant crop when it is too dry for other cucurbits. In an unfavorable season in Kansas the yield at the station was 21½ tons per acre. It was believed that in a favorable year the yield would be 40 or more tons. The melons keep well and may be stored in any convenient room where they will not freeze. They are relished by cattle, pigs, and poultry, and, in small quantities, by horses. The melons have a tough rind and must be cut or chopped before feeding. Analysis shows that they contain a high percentage of water and litttle protein. They are therefore to be classed with such succulent foods as green corn fodder, silage, root crops, etc.

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[1] The North Dakota Station has shown that the feeding of millet hay to horses as the only coarse fodder is attended with very serious and often fatal results.

In the following table are given analyses of stock melons and some common feeding stuffs of similar composition:

Analyses of stock melons and other feeding stuffs of similar composition.

	Water.	Dry matter.				
		Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Stock melon (Kansas)	95.22	0.38	0.81	61.26	21.15	7.40
Stock melon (Oklahoma)	93.03	7.97	3.77	58.90	22.02	7.34
Corn silage	79.10	8.00	3.80	53.00	28.70	6.50
Corn fodder (field cured)	42.20	7.80	2.80	60.10	24.70	4.60
Corn fodder (cut green)	73.40	7.50	3.20	58.70	25.20	5.40
Corn stover (field cured)	40.10	6.40	1.70	53.20	33.00	5.70
Carrots	88.60	10.00	3.70	66.30	11.20	8.80

It has been calculated that 1 ton of stock melons is equivalent to 670 pounds of corn silage, 240 pounds of field-cured corn fodder (with ears), 525 pounds of green dent corn fodder, 235 pounds of field-cured corn stover (without ears), or 1,410 pounds of carrots.

So far as can be learned no experiments have been made on the digestibility of the stock melon, but the assumption seems warranted that it is as digestible as the other feeding stuffs named in the above comparison. At the Kansas Station the melons were fed to cattle with satisfactory results. "It may be here remarked that while they did not furnish much nourishment they gave the animals a better appetite, and thus indirectly influenced the productive capacity of the stock. They furnish in a cheap form the succulent food which is so intensely craved by cattle in the winter months. Farmers who do not use silage and who will not undertake the trouble and expense of raising roots can raise a crop of stock melons at little expense, which, fed along with hay and corn fodder, will make the rations more palatable and result in a sharpened appetite, greater consumption, and, as a consequence, better returns in meat or milk."

A correspondent in Florida writes that he has fed stock melons daily to cows for over a year with satisfactory results. They were chopped and fed in the same way as turnips or carrots. He adds that when a piece of ground in Florida is once planted to stock melons they may be gathered at almost any time, the vines continuing to grow and fruit.

Where succulent food of other sorts is abundant, there is, perhaps little reason for raising the stock melon. There are, however, many regions where it may be of advantage to grow a crop which may be so readily stored, and which furnishes, as in Florida, at almost any season a palatable succulent food.

Individual farmers should consider carefully the suitability of the stock melon to their region and local conditions, and should experiment with it on a small scale before attempting to grow it in quantity.

THE STARCH CONTENT OF POTATOES.

The value of a potato crop to the grower depends mainly upon the yield and the size, form, and healthy condition of the tubers. Perfect tubers find ready sale at the best prices, while the yield in itself has no effect on the transaction, and the chemical composition of the potatoes is, as a rule, disregarded by the buyer, unless they are to be used in starch making. In every 100 pounds of average potatoes there is 75 pounds of water; of the remaining 25 pounds about 20 pounds is carbohydrates (starch and sugar, etc.) and 2 pounds protein. The chief value of the potato for food as well as for starch making lies in the starch which the tubers contain. The protein content is low and the carbohydrates high, and, therefore, potatoes are especially valuable for use in connection with foods rich in protein, such as lean meat, eggs, etc., to furnish a well-balanced diet. The subject of the starch content of potatoes is thus seen to be one of great importance, and during recent years it has attracted increased attention from American and European investigators.

An interesting study of the conditions affecting the starch content of potatoes, begun in 1889, is reported in the Annual Report of the Wisconsin Experiment Station for 1895. In these investigations the starch content was approximately determined by means of the specific gravity of the tubers. "Since by far the greater part of the potato tuber is starch and water, and since starch is heavier than water, it is evident that the variation in starch content will affect the specific gravity of the tuber."

Among the 46 varieties of the crop of 1889 the variety Zenith showed the highest starch content, 22.9 per cent, and Rural Blush the least, 13.1, the average for all varieties being 16.2 per cent. In 1890, 31 varieties, mostly different from those tested the year previous, had an average starch content of 14.3 per cent, Burbank showing the highest, 17.7, and the "Kidney," a potato from Germany, the least, 11.4 per cent. All these varieties of potatoes were grown on the same kind of soil and under practically the same cultural conditions. Still, the variation in starch content was as much as 9.8 per cent.

The starch content was found to vary with the season with different tubers of the same variety. Pronged and regular tubers of 4 varieties were tested separately, and in each case it was found that the percentage of starch in the pronged tubers was smaller than in the regular tubers. This seems to be one of the causes of the variation in the starch content above referred to.

A test of different-sized tubers of the same variety proved that there was practically no difference in the starch content of large and small tubers. In a comparative test during 2 years of planting the lightest and heaviest tubers of the same variety under uniform conditions, no effect on the quality of the crop was noted. These results must not be taken, however, as conclusive that the quality of the potato can not

be improved by careful selection of seed. Whether potatoes will degenerate if grown continuously from light seed is still an open question.

In studying the influence of the depth at which tubers grow in the soil upon the starch content, the author found the first year that in every case the percentage of starch was largest in the deeper-growing tubers and smallest in those growing nearest the surface. "When we consider the slight variation in depth at which the tubers grow in the soil these facts are significant." The next year the experiment was repeated with a trial of level and hill culture. The results, shown in the following table, confirm those of the first experiment:

Influence of depth of potatoes on starch content.

Kind of culture.	Starch content of potatoes.		
	Planted shallow.	Planted at medium depth.	Planted deep.
	Per cent.	*Per cent.*	*Per cent.*
Level	14.3	14.5	14.7
Hill	12.8	13.3	13.7

The level culture gave a higher [starch content] than hill culture, and the variations with the depth were greater in the hill culture than in the level culture. These facts suggest a possible explanation of the depth influence, viz, that it acts through the temperature of the soil. The deeper tubers are in a cooler medium than the shallow ones, and soil that is hilled is warmer in warm, dry weather than that which is not hilled. The variation of temperature in the deeper and shallower layers would naturally be greater in the hilled soil. The possible value of mulching during the formative season of the tubers, as a means of increasing the starch content, is suggested by the above facts, particularly in localities of hot and dry summers, like our own State.

In experiments in planting at different distances the starch content increased as the distance between the plants decreased. This seems to accord with the results of the tests of depth of planting, since close planting promotes shading of the ground and thus tends to reduce the soil temperature.

A test of scabby and healthy tubers of the Delaware variety showed a higher starch content in the scabby tubers than in the healthy ones, thus showing that scabby potatoes are not necessarily poorer in starch than those free from scab.

A POSSIBLE DANGER IN THE USE OF CRIMSON CLOVER.

The introduction of the annual leguminous plant, crimson clover, into the United States is comparatively recent, but its use as a forage plant and green manure is rapidly extending. This is easily explained by the decided advantages this clover possesses of covering and protecting the soil from washing and leaching during the winter, and of fur-

nishing a green manure for spring crops or a succulent and nutritious feed at a time when such food is likely to be scarce. It has been found, however, that there is a danger in the use of the overripe clover, especially with horses, that should be carefully guarded against. The small hairs which occur in the heads of the clover are so constructed (when the plant has passed the flowering stage) that they collect together and form large, round, impervious balls in the intestines of horses, and many cases have been reported in which these have caused the death of animals.

A recent circular of the United States Department of Agriculture states that—

When the balls have once developed to such a size that they can not pass through the intestine no practical remedy can be suggested. But the prevention of the difficulty is in most cases easy. The hairs of crimson clover do not become stiff until the plant has passed the flowering stage and begun to ripen. It should be made a rule, therefore, never to feed crimson clover after the crop has ceased flowering, and especially never to follow the pernicious practice of feeding stock with the straw of crimson clover raised and thrashed as a seed crop. By guarding against improper methods of feeding there is no reason why crimson clover should not continue to maintain its well-merited reputation and increase in use as a forage plant and green manure.

RAISING GEESE FOR PROFIT.

Raising geese for market is an important industry in Rhode Island and has proved very profitable. It stands midway in importance between the chicken and turkey industries. In view of the extent of the industry the Rhode Island Experiment Station has for several years devoted considerable attention to studying the best methods of caring for geese, the most profitable breeds and crosses, the time to market, and other similar problems.

Geese are probably the hardiest of all domestic fowl, require less attention than cows or hens, and little or no outlay for buildings. The old geese do well in all weathers with nothing in the way of shelter but a shed to run under, and usually they disdain that. They do best on wet or marshy land, where hens and turkeys would not thrive. They are, however, very different from other fowls, and unless their nature is understood and their requirements met they are the least profitable of all stock. The desirability of extending a knowledge of the best methods of geese raising, as well as making experiments that will throw more light on the subject, is evident from the facts above stated.

In a recent report of the Rhode Island Station the work of past years is summarized and a number of additional tests are reported. The following breeds and crosses were tested: Embden-Brown China, Embden-Toulouse, Brown China, Embden-African, Toulouse Brown China, Embden-White China, African-Brown China, African-Toulouse, Pure African, Pure Embden, and Prince Edwards Island.

The Embden-White China were the easiest to pick, were white when dressed, and, though small, were plump and presented an attractive appearance. The Embden-African (fig. 1) were also easy to pick and

were large and plump. The White China, though the weakest and smallest of all breeds, when mated with Embden ganders produced vigorous, quick-growing goslings, which where plump and solid when dressed. The Embden-Toulouse (fig. 2) is regarded as the most satisfactory cross for large geese for Christmas and New Year trade. Pure African and Embden and African crosses grow best early in the season and should be marketed early. Pure-bred China, African-Toulouse, and African-Brown China should be dressed before fall, in order that they may be easy to pick. White-plumaged Embden and White crosses may be picked easily and later than the others.

Old geese lay a greater number of larger eggs and are more reliable than young geese. Nevertheless, if geese must be purchased it often

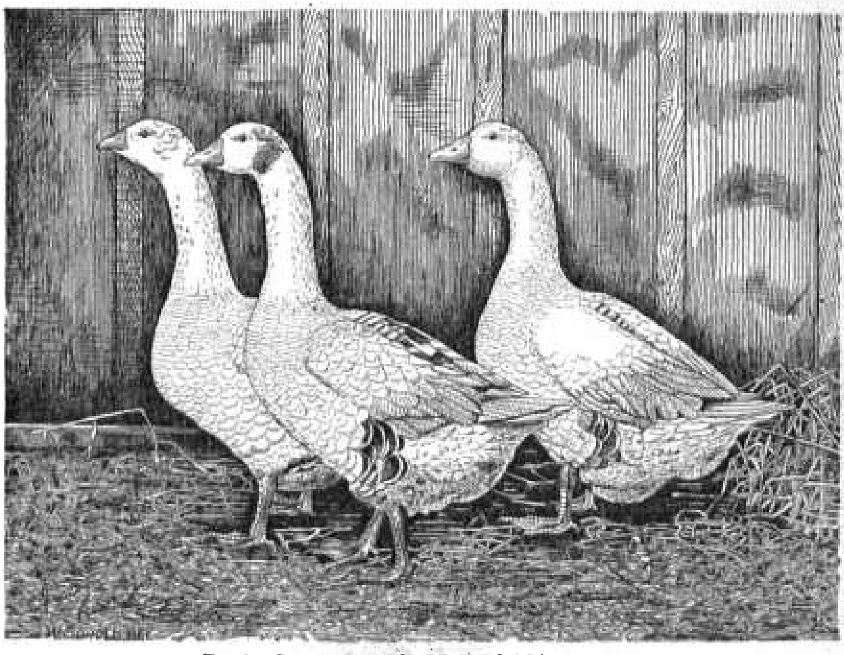


FIG. 1.—Geese crosses: Embden and African (young).

saves time to buy young geese rather than to attempt to secure any number of old ones. Young ganders are better for breeding than young geese. Young geese do not lay as many fertile eggs or produce as many goslings the first breeding season as they do the second. If geese are often changed from one place to another, they are apt not to breed well, and the other conditions being equal they breed better the third season they are in a locality than the second.

In order to insure the best results, geese for breeding should be obtained as early in the fall as possible, not later than October. They thus have an opportunity to become acquainted with their new surroundings before the breeding season. Breeding geese should have

considerable exercise and be kept moderately thin in flesh through the winter by light feeding and a free range or facilities for swimming. The best ganders for breeding purposes are African and Brown China. The Toulouse geese lay well, but often do not sit. The Embden geese lay fewer eggs, but make better mothers. Brown China and White China geese are prolific layers. Geese are graziers and too much grain is not good for them. To insure fertile eggs they should have an abundance of green food and have access to a pond or other body of water. If this is not possible a tub of water set level with the surface of the ground may be substituted. Very early laying is not desirable, since the goslings do not thrive well unless they have an abundance of grass. For the first two or three days they should be given nothing except

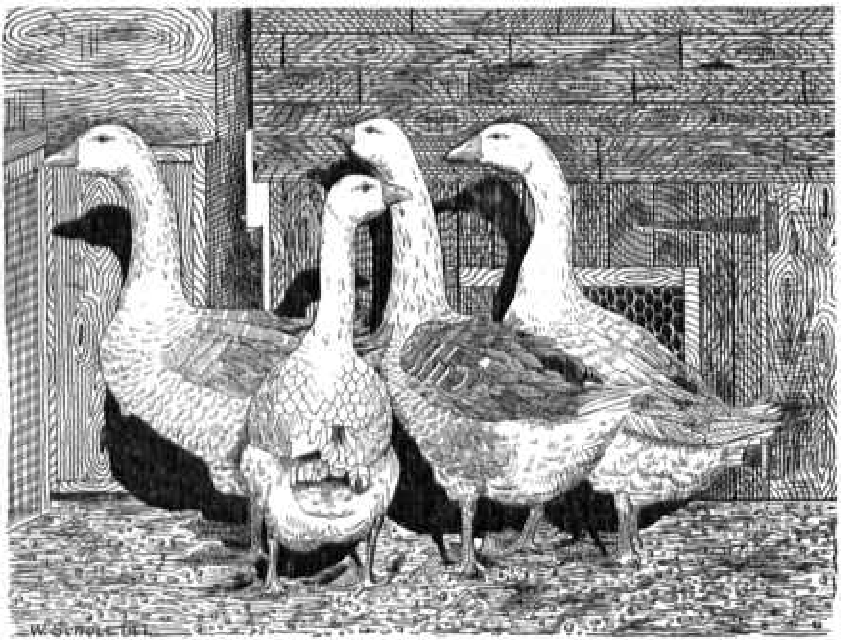


FIG. 2.—Geese crosses: Embden and Toulouse (young).

grass and water. Later a light feed of scalded cracked corn should be given in addition three times a day. The goslings are liable to be overcome by the heat, and should always have some place of retreat where they may escape the sun's rays.

The eggs may be hatched advantageously under hens, but the goslings should be immediately taken away from them. They may be brooded for a short time in outdoor brooders and after that confined in houses at night.

CROSS-POLLINATION IN RELATION TO FRUITFULNESS.

Fruit growers have frequently observed that in some cases where orchards are composed of a single variety of fruit the trees fail persistently to set satisfactory crops, while trees of the same variety in mixed

plantings yield abundantly, though in both cases the trees are apparently vigorous and blossom freely. Observations of this nature suggested that some varieties must receive pollen from other varieties in order to insure the production of fruit. Within the last five years several investigations as to the cause and the extent of this self-sterility have been reported. A number of causes are found to be operative, varying with the different fruits and the conditions under which they are grown. While in many instances self-sterility seems to be a characteristic of certain varieties, in some cases it is largely due to adverse weather.

The pollination of pears has been studied by the Division of Vegetable Physiology and Pathology of this Department. Extensive experiments were conducted in three localities in New York and one in Virginia. They were continued through two seasons and included work with 38 varieties. A majority of the varieties tested were entirely self-sterile, though they set fruit well when pollinated by other varieties. Pollen from another tree of the same variety appeared to be no more effective than from another branch of the same tree or than from the same flower. A number of varieties were found to be self-fertile, but even with these cross-pollination appeared to be more certain and more satisfactory under adverse conditions. There were shown to be marked differences between self and cross-pollinated fruits of the same variety. These were especially noticeable in the case of Bartlett and Buffum pears and also fairly well pronounced in Anjou, Angouleme, and Heathcote. Self-pollinated fruits are somewhat smaller, tend to be narrower, and not so well filled out toward the blossom end. Most of them are entirely seedless. They tend to ripen slightly later than cross-pollinated ones, this being more noticeable with late than early varieties.

The following is a list of self-sterile and self-fertile varieties of pears: Self-sterile—Anjou, Bartlett, Boussock, Clairgeau, Clapp *Favorite*,[1] Columbia, De la Chene, Doyenne *Sieulle*, Easter, Gansel Bergamotte, Gray Doyenne, Howell, Jones, Lawrence, Louise *Bonne*, Mount Vernon, Pound, Sheldon, Souvenir *du Congres*, Superfin, Colonel Wilder, Winter Nelis. Self-fertile—Angouleme, Bose, Brockworth, Buffum, Diel, *Doyenne d'*Alencon, Flemish *Beauty*, Heathcote, Kieffer, Le Conte, *Manning* Elizabeth, Seckel, Tyson, White Doyenne.

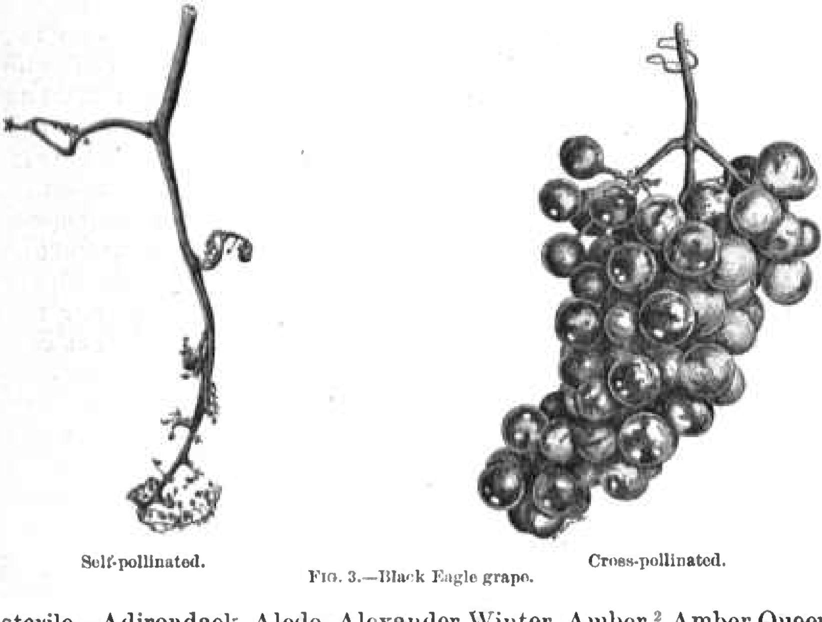
Experiments were made with apples and quinces similar to those with pears. The quince was found to fruit nearly as well with its own pollen as with that of another variety. With regard to apples, the report says: "The varieties of apples are more inclined to be sterile to their own pollen than the pears. With the former, in the great majority of cases, no fruit results from self-pollination. The results as a rule,

[1] Words in italics, according to the recommendation of the American Pomological Society, are to be dropped eventually from variety names, but are retained for the present to prevent confusion.

however, were less clear cut than in the pear, because with most of the self-sterile varieties an occasional fruit will set under self-pollination and none of the varieties were very completely self-fertile."

The following is a list of self-sterile and self-fertile varieties of apples: Self-sterile—Yellow Bellflower, Chenango, Gravenstein, Tompkins King, Melon, Northern Spy, Primate, Rambo, Red Astrachan, Roxbury, Spitzenburgh, Tolman *Sweet*, Newtown Pippin.[1] Self-fertile—Baldwin, Codlin, Greening.

The New York State Station has studied the sterility of grapes for several years. Of the 145 varieties studied, 86 are practically self-fertile and 59 are either entirely self-sterile or produce imperfect clusters when self-pollinated. An experiment with grapes has also been made at the Georgia Station. Of 116 varieties tested, 90 are mostly self-fertile and 26 mostly self-sterile. The Minnesota Station has also reported results along the same line with a few varieties. The following is a summary of the self-sterile and self-fertile varieties: Self-



Self-pollinated. Cross-pollinated.

FIG. 3.—Black Eagle grape.

sterile—Adirondack, Aledo, Alexander Winter, Amber,[2] Amber Queen, America, Aminia, Barry, Beagle, Black Eagle (fig. 3), Black Pearl, Blanco, Brighton, Burnet, Canada,[2] Canonicus, Clevener, Collier, Creveling, Daisy, Denison, Dracut Amber,[2] Duchess,[2] Early Market,[2] Eldorado, Elvibach, Essex, Eumelan, Faith,[2] Fanny, Gærtner, Geneva, Gold Dust, Grein Golden, Hayes,[2] Herbert, Hercules, Hexamer, Jewel, Juno, Letorey, Lincrup, Lindley, Marion, Mary, Massasoit, Maxatawney, Merrimack, Montefiore, Moyer, Nectar, Noah, Northern Muscadine,[2]

[1] Based on reports of fruit growers.

[2] Results of different workers disagree as to sterility of this variety.

Norwood, Red Bird, Red Eagle, Requa, Rogers 2, Rogers 5, Roscoe, Ruby, Rustler, Salem, Sultan, Texas Highland, Transparent, White Jewel, Wilder, Woodruff, and Wyoming. Self-fertile—Agawam,[1] Alice, Allen Hybrid, Ambrosia, Bacchus, Beacon, Bell, Belvin, Berckmans, Bertha, "Big B Con," Big Hope, Brant, Brilliant, Burrows 42c, Cambridge, Carman, Catawba, Caywood 50, Centennial, Champion, Chandler, Clinton, Colerain, Concord, Conqueror, Cottage, Courtland, Croton, Cunningham, Cynthiana, Delaware (fig. 4), Diamond, Diana, Downing, Early Golden, Early Ohio, Early Victor, Eaton,[2] Edmiston 1, Elsinburgh, Elvicand, Elvira, Empire State, Esther, Etta, Glenfield, Goethe,[2] Golden Grain, *Gov.* Ross, Grayson, Grein 7, Hartford, Herald, *Herman* Jaeger, Highland, Hopican, Hosford, Humboldt, Illinois City, Iona, Isabella, Isabella Seedling, Israella, Ives, Janesville, Jefferson, Jessica, Judge, Kemp, Lady, Lady Washington, Leader, Leavenworth, Lindmar, Linn Queen, Little Blue, Louisiana, Lutie, Mabel, Marguerite, Marvin Seedling, Mary Favorite, Matilde, Metternich, Mills, Missouri Riesling, Monroe, Moore Early, Mrs. Munson, Niagara, Nimalba, Norton *Virginia,* Olita, Opal, Oriole, Paradox, Paragon, Perkins, Perry, Pizarro, Pocklington, Poughkeepsie Red, Prentiss, Presly, Profitable, Pulpless, Ragan, Roanoke Red, Rochester, Rockwood, Rogers 13, Rogers 24, Rogers 32, Rommel, Rutland, Senasqua, Standard, Sweety, Telegraph, Triumph, Ulster, Van Deman, Vergennes, Victoria, Wheaton, Whites Northern Muscat, Winchell, Worden.

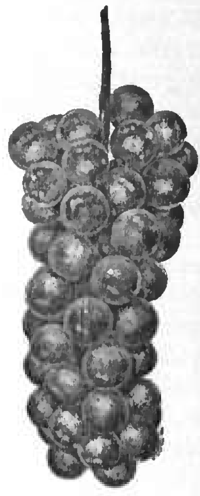


FIG. 4.—Delaware grape, self-pollinated.

Work with plums indicates that cross-pollination is advantageous in many cases and necessary in at least a few. At the Vermont Station it was found that but 1 variety out of 14 tested set fruit normally by self-pollination. Other experimenters have obtained similar results. The European and Japanese plums have not as yet been shown to need cross-pollination, self-sterility being confined, so far as known, to American plums. There are some indications, however, that there are cases of it among the prunes grown on the Pacific Coast. It is probable that some cases of apparent self-sterility in plums are in reality due to defective pistils rather than to any impossibility of self-fecundation. Studies made at the Wisconsin, Vermont, and Iowa stations all show that often a high percentage of the flowers of some varieties have defective pistils. This tendency in some cases appears to be an individual rather than a varietal character.

The following list is a summary of the present knowledge of the tendencies to self-sterility in plums: Self-sterile varieties—Black Hawk,

[1] Results of different workers disagree as to sterility of this variety.

[2] The self-fertility of this variety is questionable.

Cheney, Agen,[1] De Soto,[2] Italian,[1] Itasca, Ogon, Minnesota, Minnesota Seedling 2, Minnesota Seedling 3, Minnetonka, Miner, Original Minnesota, Pottawattamie, Rollingstone, Wazata, Wild Goose, Wolf,[2] Wolf Seedling 2, Wolf Seedling 5, Wolf Seedling 6, Wolf Seedling 7. Self-fertile varieties—Deep Creek, Golden Beauty, Hunt, Marianna, Moldavka, Moreman, Newman, Purple Yosemite, Robinson, Wayland.

In a single test with peaches, reported by the Delaware Station, the following varieties either failed to fruit or fruited poorly when covered to prevent cross-pollination: Alexander, Crawford Early, Fox, Mary Choice, Mountain Rose, Oldmixon, Reeves *Favorite*, Salway, Smock, Stump, Wager. Moore Favorite, though not perfectly fruitful, was more nearly so than the other varieties.

The California Station has reported a single year's experiment with olives. All the small varieties tested failed to set fruit when their blossoms were confined in paper bags; all the large ones were self-fertile, and the medium ones showed variable tendencies. The following varieties produced little or no fruit, at best only dwarfed fruit, when cross-pollination was prevented: Atrorubens, Aroviolacea, Huff Spanish, Mission, Pendulina, Præcox, Rubra, Salonica, and Verdale. The following varieties are self-fertile: Columbella, Macrocarpa, Lucques, Manzanillo, Oblonga, and Polymorpha.

Among other fruits, certain varieties of which have given some indications of self-sterility, are the raspberry, blackberry, dewberry, and gooseberry. With strawberries it has long been known that certain varieties, pistillates, will not produce fruit satisfactorily unless mixed with perfect-flowered varieties.

Since many of the self-sterile varieties of fruits are the most desirable, discarding them from use is out of the question. The difficulty can be largely overcome, however, by setting such varieties in mixed orchards. This may be advantageous even with self-fertile varieties, for the experiments noted indicate that in some cases self-fertile varieties produce better fruit when cross-pollinated. Some writers advise planting the trees of the two varieties that are to inter-cross very close together. This will probably not be found necessary, however, where bees or other pollen-carrying insects are abundant. In cases of unproductive orchards of but a single variety, top-grafting part of the trees with other varieties is recommended. Care must be taken to mix varieties that bloom at the same time. Many stations are making records of the blooming time of the various fruits, but the question of what varieties bloom together is influenced so greatly by locality and other little-known factors that no comprehensive statement can be made about it at present. It is known, for instance, that in certain cases varieties which blossom a day or two apart in the North blossom as much as a week apart in the South; and instances are known where in a peculiar

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[1] Based on reports of fruit growers.

[2] Results of different workers disagree as to sterility of this variety.

season the usual order of blossoming of the two varieties has been reversed.

As to whether the pollen of a certain variety of fruit is specially adapted to pollinating a certain other variety is not very certain. The work with pears has not shown that any such affinities exist between varieties. The differences between the various crosses were slight or variable. Work with plums by C. W. H. Heidemann, of the New Ulm Experiment Station in Minnesota, indicates, on the contrary, that varietal affinities may exist. A few blossoms of the Wolf Plum pollinated by Hiawatha gave fruit very superior to that from other pollinations. Self-fecundated fruits were inferior to those cross-pollinated by Hiawatha and Hammer, but superior to those pollinated by New Ulm, Early Red, Carolina, and a new species from Minnesota. If such cases are at all general, indiscriminate mixing of varieties may do more harm than good. Probably the safest course at present is to be governed largely by botanical relationships and avoid mixing varieties of very distinct species.

NITRAGIN, A GERM FERTILIZER FOR LEGUMINOUS PLANTS.

FIG. 5.—Roots of soy beans showing tubercles (slightly reduced in size).

It had long been known that leguminous plants, such as clover, peas, beans, etc., were unusually rich in nitrogen and flourished on soils which were very deficient in nitrogen, but it was not until within comparatively recent years that the true cause of this was made known. It was shown that leguminous plants were able to draw on the vast stores of nitrogen in the air through bacteria living in nodules or tubercles on their roots. The presence of these nodules or tubercles on the roots of legumes had long been known. They can readily be seen by examining the roots of leguminous plants grown under conditions favorable to their production, i. e., in soils deficient in nitrogen which have borne the same plant the previous year. (See fig. 5.)

In soils abundantly supplied with nitrogen there is little need for the bacteria and the nodules which they produce are not so likely to occur on the roots in such soils. On the other hand in soils poor in nitrogen

the bacteria, if present in sufficient quantity, attach themselves to the roots in large numbers and stimulate the plant upon which they grow to produce the tubercles and provide the necessary nutritive substance for the growth of the bacteria, while in return the plant receives the nitrogen which the bacteria alone can take from the air and render available for use by the plant. In this way a copartnership (or symbiosis, as it is called) is set up between the plant and the bacteria by means of which the plant is enabled to secure, even on soils poor in nitrogen, a sufficient amount of this element to build up the nitrogenous substances in which leguminous plants are so rich.

It had often been noted, however, that when a leguminous plant was grown for the first time on a soil, it frequently produced no tubercles and failed to thrive, and this was true even though some other leguminous plant had been successfully grown on the same soil the previous year. This led to the conclusion that each leguminous plant has its own peculiar kind of bacteria and is not likely to thrive unless these bacteria are present in the soil. This conclusion has been confirmed by investigations in Europe and by experiment stations in this country (notably Illinois and Louisiana).

When this fact was demonstrated the next step was to provide a practical means of introducing the desired bacteria into the soil, i. e., of inoculating the soil. The first method suggested for this purpose was to spread over the plat or field soil taken from a field where the desired crop had been successfully grown. While this method proved quite successful, it was somewhat inconvenient and not always reliable. Nobbe and Hiltner, two German investigators, prepared pure cultures of the specific organism which was believed to act favorably in the case of each leguminous crop and used these instead of the soil for inoculation.

These "pure cultures," under the name of Nitragin, are now made on a commercial scale in Germany and are protected by letters patent. The list of plants for which pure cultures have been made includes peas, beans, vetches, lupines, clovers, alfalfa, sainfoin, serradella, flat pea, kidney vetch, and melilotus.

Two methods of using the Nitragin are followed: (1) Inoculation of the seed direct, by bringing it, by means of water, into contact with the Nitragin, and (2) inoculation with the Nitragin of some of the soil of the field on which the crop is to be sown, and then spreading this soil over the plat and working it in to a depth of about 3 inches. The cost of inoculation is estimated at about $1.25 per acre.

While encouraging results have followed the use of this material, it should be clearly understood that the whole matter has not yet passed beyond the experimental stage. European investigators are giving much attention to the subject, and several of the American experiment stations (Alabama, Connecticut, Louisiana, Massachusetts, and possibly others) have investigations in progress along this line. It remains for

these investigations to determine whether the method is practicable and likely to be of any material benefit to agriculture.

RECENT INVESTIGATIONS ON LIME AS A FERTILIZER.

Liming is a very old agricultural practice, and the importance of lime as a fertilizer has long been recognized, although its true value is being largely explained by investigations that are now in progress. As a rule the beneficial effect of lime has heretofore been ascribed mainly to its action in improving the texture and drainage of the soil, in hastening the decomposition of organic matter in the soil, in rendering the inert nitrogen of the soil humus more available to plants, and in assisting in setting free the potash and other inert fertilizing constituents of the soil. While all these benefits may fairly be expected to result from the use of lime under proper conditions, recent investigations have shown that it performs other equally important functions in the soil, and that its abundance or deficiency there is a matter of greater importance than it was formerly supposed to be.

It has been generally assumed that there is a sufficient quantity of lime in most soils to meet the demands of ordinary crops. The Minnesota, Rhode Island, and other stations have shown that except in limestone regions it is as likely to be deficient as potash or phosphoric acid. Especially is this true of soils derived from the decomposition of granite. In testing the fertilizer requirements of soils it becomes as important, therefore, to determine whether lime is deficient as whether potash and phosphoric acid are lacking. A deficiency of lime may be due to the continued growth and removal of crops without liming, or to leaching out of lime, a process which is continually going on, and which is greatly hastened by the use of certain fertilizers, especially muriate of potash, as pointed out in Experiment Station Work—I, p. 16. The liberal use of muriate of potash and similar fertilizers on a soil not abundantly supplied with lime should be accompanied by periodical applications of lime.

A deficiency of lime in the soil is accompanied by a state of acidity, or sourness, fatal to the vigorous growth of many crops. The Rhode Island Station has shown that this condition of acidity is widespread even in upland soils which are well drained and not supposed to be sour, as well as in low, wet soils. It was found in experiments at this station with different forms of nitrogen that sulphate of ammonia was positively poisonous to plants on such soils when it was not used in connection with lime. When the acidity of the soil was corrected by applications of air-slacked lime, the sulphate of ammonia was beneficial. This beneficial effect of lime was probably largely due to the fact that the lime restored the alkaline condition of the soil necessary to the transformation (by nitrification) of the sulphate of ammonia into the nitrates so necessary to most crops. The station has grown some 150 varieties of plants on these acid soils before and after liming. In

these experiments the limed plats received air-slacked lime at the rate of 5,400 pounds per acre in the spring of 1893, and 1,000 pounds in the

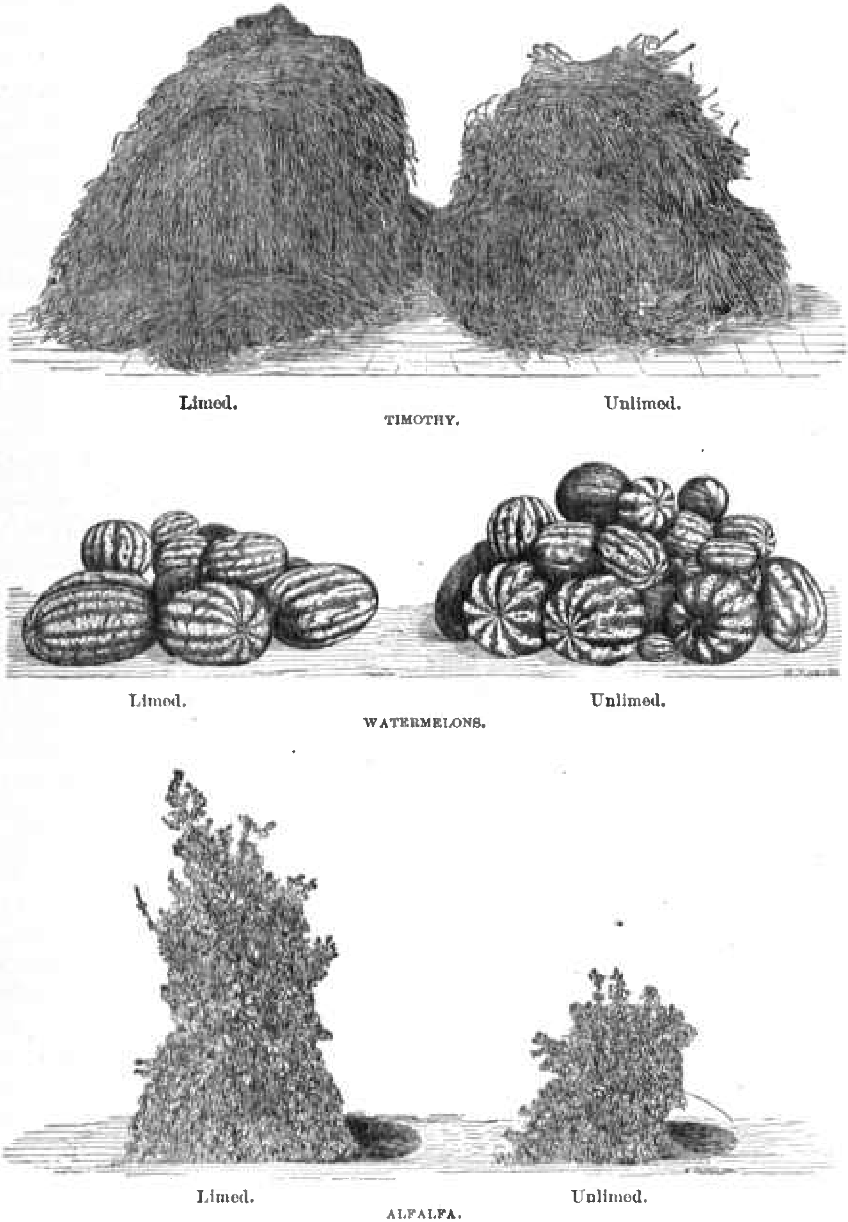


FIG. 6.—Effect of lime on different crops.

spring of 1894. The results have been very decisive. Some of the more striking of them are shown in fig. 6.

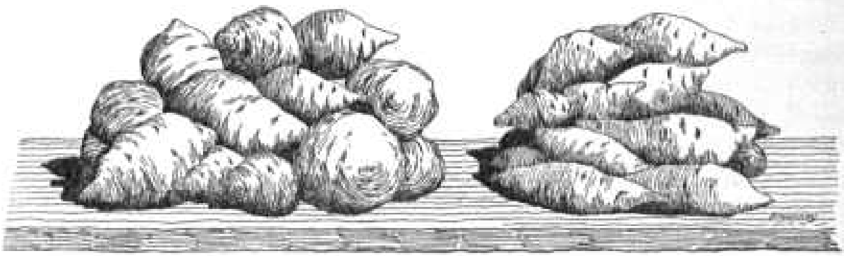
A report of the Rhode Island Station summarizes the results of all of these experiments as follows:

The following vegetables have shown this season [1895] benefit from liming, decreasing in the following order: Onions (Egyptian), celery, onions (Barletta), pumpkins, mangel-wurzels, muskmelons, carrots, table beets, dandelions, cabbages, kohl-rabi, and flat turnips.

Carrots and pumpkins, which showed an apparent injury from lime in 1894, have given an increase upon the limed plats in 1895. It is possible that these two plants should be introduced into a rotation a year or two after the lime has been applied in order to secure the best results, a point which can only be ascertained with certainty by further experiments.

The watermelon showed a decided injury from liming in 1894, which was even more marked in 1895. In this particular the watermelon stands in marked contrast to the muskmelon, which was practically a failure both years except upon the limed plats.

Alfalfa, like clover, has shown a decided benefit from liming, while serradella and blue lupine have, on the contrary, been injured thereby. The injury to the



Limed. Unlimed.

FIG. 7.—Sweet potatoes.

lupine has been observed in each of the 3 years of the experiment, though it was greatest in 1894, immediately following the second application of lime.

Common sorrel has shown an injury from liming during both of the years in which it has been grown, though the injury was greatest in 1894, immediately following the second application of lime.

The observations with the different grasses indicate that timothy, Kentucky blue grass, awnless brome grass, and others may be benefited by lime in varying degrees, while the sweet vernal, soft grass, Rhode Island bent, and sheep's fescue indicate less or no benefit from its use. These results with grasses, as has been stated previously, are those obtained from the first season's growth, and can not therefore be so conclusive or satisfactory as the results of succeeding seasons. It appears probable, however, that the individuality of the grasses in respect to their benefit or injury from liming may be as great as that of the individual members of the leguminous, melon, and other families of plants.

The tests in 1896 gave the following results: Benefited by liming (about in the order given), spinach, carrots, mangel-wurzels, dandelions, barley, crimson clover, sheep's fescue, rye, timothy, Kentucky blue grass, awnless brome grass, Rhode Island bent, meadow soft grass, and meadow oat grass; injured by liming, redtop, gladiolas, and blue lupine.

The use of lime has been shown to have a marked effect not only on the yield, but also on the quality of the crop, especially of certain root crops. The experiments of the Rhode Island, New Jersey, and North Dakota stations with potatoes have shown that while applications of lime may greatly increase the yield they also increase the amount of scab.[1] On the other hand, lime (at the rate of 75 bushels per acre) has been found by the New Jersey Station to be a very effective preventive of club root of cabbage and turnips, and to reduce the soil rot of sweet potatoes. It has been further shown in experiments at the New Jersey Station that lime tends to make sweet potatoes round. This interesting point is illustrated in fig. 7 (p. 23).

ARE ASHES AT PRESENT PRICES AN ECONOMICAL FERTILIZER?

Ashes are the residue resulting from the burning of trees or other plants, and therefore contain all the mineral constituents necessary to the growth of plants. For this reason it would seem that ashes are an ideal fertilizer as far as chemical composition is concerned, but as a matter of fact, although the mineral constituents are present in pure ashes in the proportions in which they are actually taken up by plants, they are not, except in the case of potash, present either in the form or the proportions to supply the best balanced and most effective fertilizer. In other words, they are a one-sided fertilizer. They are, of course, entirely deficient in one of the three essential fertilizing constituents, nitrogen, and the small amount of phosphoric acid which they contain is of comparatively little importance. Their value as a fertilizer, therefore, depends primarily upon the potash which they contain, and they may be expected to give their best results when used on soils or crops especially requiring potash. It is for this reason that ashes have proved so valuable as a fertilizer in New England, where experiments have shown the soils to be generally deficient in potash; and on such crops as potatoes, tobacco, clovers, and fruits, which are preeminently potash feeders.

It is not fair, however, to ascribe the fertilizing value of ashes exclusively to the potash they contain. The small amount of phosphoric acid present is not without fertilizing value, and the lime, which they contain to the extent of 600 to 700 pounds per ton (of 2,000 pounds), is of great value in improving the texture and in correcting the acidity of soils, besides supplying an element which is deficient in many soils. (See p. 21.)

That the fertilizing value of ashes does not depend entirely upon the potash present is proved by the fact that leached ashes, from which the larger part of the potash has been removed, are used as a fertilizer with highly beneficial results.

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[1] Experiment Station Work—I, p. 22.

There is no doubt, therefore, that ashes are a valuable fertilizer when used with proper care and discrimination, but there is considerable danger that their value may be (and is at present) overestimated by farmers, and money is expended in many cases in the purchase of ashes which might be more economically used in the purchase of other forms of commercial fertilizers. In New England and New York, where ashes are probably more largely used than in any other part of the United States, the usual price is from \$10 to \$12 per ton. It is important to know whether at this price the fertilizing constituents which ashes contain are as economically purchased as in other standard fertilizing materials.

Hundreds of analyses of ashes found in the market have been made by the experiment stations. The averages of these analyses show that unleached wood ashes contain about 5 per cent of potash, 1.5 per cent of phosphoric acid, and 32.5 per cent of lime, or 100 pounds of potash, 30 pounds of phosphoric acid, and 650 pounds of lime per ton. If we apply to ashes the schedule of prices commonly used in the valuation of other fertilizing materials, i. e., assume that potash is worth 5 cents a pound (the price of potash in the best forms) and phosphoric acid 5 cents (which undoubtedly greatly exceeds the real value of the phosphoric acid in ashes), we find that the actual fertilizing constituents (potash and phosphoric acid) in a ton of average unleached wood ashes can be bought in the best forms in the market for \$6.50. It is clear that if ashes are employed simply for the potash and phosphoric acid they contain they are an expensive fertilizer at \$10 to \$12 per ton.

Attention has already been called to the fact that it is probable that a large part of the beneficial effect of wood ashes is due to the lime which they contain, but it is questionable whether this is an economical form in which to apply lime, for if we assume that average unleached ashes sell for \$10 per ton, and allow 5 cents per pound each for the phosphoric acid and potash, as in the above calculation, the 650 pounds of lime present costs \$3.50. This is at the rate of 54 cents per 100 pounds. In the same way we find that if the ashes cost \$12 a ton the lime costs 84 cents per 100 pounds. Probably there are, however, few places in the regions in which wood ashes are extensively bought for fertilizing purposes where 100 pounds of lime in the form of oyster shell or stone lime can not be bought for from 30 to 50 cents per 100 pounds. One dollar per barrel of 250 pounds is considered a liberal price to allow for commercial lime in New England at the present time. Assuming that such material contains (as it should) 95 pounds of actual lime (CaO) in every 100 pounds, 100 pounds of lime costs 42 cents in the New England market. During the past year lime could be bought in bulk in New England for 75 to 80 cents per barrel, or at the rate of 31.5 to 33.6 cents per 100 pounds of actual lime. If, however, we assume the lime to be worth 42 cents per 100 pounds, we find the value of the potash, phosphoric acid, and lime in a ton of wood ashes to be \$9.23.

As has been said, ashes find their widest application as a potash fertilizer, but notwithstanding the fact that the potash (carbonate) which they contain is in one of the best forms for crops, it is, with present market prices for ashes, quite expensive as compared with other good forms of potash found in the market. If we allow 5 cents a pound for phosphoric acid and 42 cents per 100 pounds for the lime in average unleached wood ashes, selling at from $10 to $12 per ton, the price per pound of potash ranges from 5¾ to 7¾ cents. Potash in the best high-grade sulphate is worth in the regions where ashes are extensively used 5 cents per pound, while in the form of kainit and muriate it is worth from 4 to 4½ cents.

It should be remembered, moreover, that wood ashes as found on the market vary widely in composition. A classification of 161 analyses of wood ashes made by the New England experiment stations shows that 23 samples contained less than 4 per cent of potash, 58 between 4 and 5 per cent, 38 between 5 and 6 per cent, 23 between 6 and 7 per cent, and 19 over 7 per cent. The most common percentages of potash were, therefore, from 4 to 5, or from 80 to 100 pounds of potash in one ton of ashes, and between 1 and 2 per cent of phosphoric acid, or from 20 to 40 pounds per ton. Thirty-one of the samples collected were designated "Canada hard-wood ashes." Of these, 6 samples contained less than 4 per cent of potash, 15 between 4 and 5 per cent, 3 between 5 and 6 per cent, 4 between 6 and 7 per cent, and 3 over 7 per cent. The percentage of water varied from less than 1 per cent to over 30 per cent. Seventeen samples showed over 20 per cent of water, or 400 pounds per ton. The most common amount was between 10 and 12 per cent, or from 200 to 240 pounds per ton. One sample contained 500 pounds of water per ton. These figures show very clearly that the above estimates are likely in many cases to be far above the actual value, and that wood ashes, like other fertilizing materials, should be bought only on strict guarantee of composition.

As the New York State Station points out, there are no ashes found on the market agreeing in composition with that of pure, unleached hard-wood ashes so frequently advertised. By burning different varieties of air-dried hard and soft woods in a furious fire on an open hearth, this station obtained hard-wood ashes which contained 13.09 per cent of potash and 2 per cent of phosphoric acid, and soft-wood ashes which contained 6.94 per cent of potash and 2.1 per cent of phosphoric acid. When burned at a low temperature the hard-wood ashes contained 17.35 per cent of potash and the soft-wood ashes 9.61 per cent of potash. The discrepancy between the composition of these carefully prepared ashes and those usually found on the market is due either to leaching or to accidental or intentional admixture of other substances. "In collecting wood ashes from log heaps on newly cleared land it is difficult to avoid taking up with them some of the underlying earth. It is very easy also to adulterate them purposely with leached wood ashes, coal ashes, or soil."

What has been said regarding wood ashes may be briefly summed up in the words of a recent report of the New York State Station:

While it is probably true that ashes are bought for and their beneficial effect is mainly due to the potash they contain, it is clear that the potash is thus obtained at an excessive price as compared with its commercial value in the several potash salts of the German mines, but it must not be forgotten that the other constituents of ashes have an agricultural value, direct or indirect, which may often justify their application even at their present prices and average composition; but it is important for the purchaser to remember that there is really no significance in the term "pure, unleached ashes," and a guaranteed percentage of potash, as also freedom from any adulteration, should be insisted upon, since it would be an easy matter to increase the percentage of potash by admixture with a sufficient quantity of the cheaper potash salts.

The above statements regarding wood ashes apply in large measure to another valuable fertilizing material of similar character, viz, cotton-hull ashes. Cotton-hull ashes are much richer in fertilizing constituents than wood ashes and are highly esteemed, especially in New England, as a fertilizer for tobacco. They contain on an average about 23 per cent of potash, 9 per cent of phosphoric acid, and 8.8 per cent of lime, although their quality varies greatly. The great demand for these ashes by tobacco growers, with the limited supply, has caused the price of the potash they contain to rise much higher than that of potash in other standard fertilizing materials. The average cost of potash in 31 samples of cotton-hull ashes recently analyzed by the Connecticut State Station was 6.6 cents per pound. The potash (carbonate) is in a form well suited to tobacco, but farmers may well question the economy of paying 6.6 cents per pound for potash in this form for general purposes when, as explained above, potash in the form of the best high-grade sulphate can be bought for 5 cents per pound. The high percentage of phosphoric acid which these ashes contain, however, make them a valuable source of this fertilizing constituent.

CAN FARMERS MIX THEIR OWN FERTILIZERS ECONOMICALLY?

Many of the experiment stations have for several years past been studying this question in connection with their work in the official inspection of fertilizers. The unanimous conclusion reached by the stations which have given the closest attention to the subject is that it is entirely practicable and economical under certain conditions for farmers to buy the different fertilizing materials in the crude stock and to mix them on the farm, and they have made every effort to encourage and assist them in the practice.

It has been clearly shown that when farmers combine together and purchase their supplies in large quantities for cash and make their own mixtures, they secure their fertilizers at a greatly reduced cost. An examination by the New Jersey Station in 1895 of home mixtures made by farmers in different parts of the State, representing in the aggregate a purchase of over 1,000 tons, showed that these mixtures cost on an average $28.62 per ton, while the fertilizing ingredients which they

contained, at the station valuations, were worth $31.68. In the average factory-mixed fertilizer the same ingredients would have cost $43.12. "At the rate here indicated there was a saving of $14,500, certainly a good return for cash payments instead of credit, for selecting materials high-grade and suited to the needs of the soil or plant instead of by hit or miss, and for using the regular labor of the farm in mixing instead of paying others who do the work no better." In 1896 the home mixtures examined by the station cost on the average $26.18 per ton, while their average valuation was $28.34, "indicating a saving on the part of the consumer not only of the difference, $2.16, but also of the additional expenses involved which would have been paid if the average commercial mixture had been purchased."

As stated above, however, this saving can only be secured by cooperation on the part of farmers, so that the fertilizing materials can be purchased in bulk for cash. The market prices of the fertilizing materials bought in small quantities are frequently so high as to render home mixing impracticable. The individual farmer rarely uses fertilizers in sufficient quantity to enable him to secure the advantage of wholesale quotations on unmixed fertilizing materials, but farmers' clubs, granges, etc., may buy the crude stock in carload lots and thus secure the full advantage of reduced price for purchase in bulk.

It has repeatedly been urged that it is not practicable for farmers to mix their own fertilizers, because mixing can not be satisfactorily done with the ordinary facilities of the farm; but reports of a large number of practical and successful farmers in Connecticut, New Jersey, Rhode Island, and other States have shown beyond question that fertilizer mixtures uniform in quality, fine, dry, and equal in all respects to the best factory-made fertilizers, can be and are annually made on the farm without the aid of milling machinery.

A tight barn floor, platform scales, screen, shovel, and hoe are the only utensils needed. The materials being weighed, screened, and lumps pulverized, the most bulky stock is spread in an oblong pile from 6 to 12 inches deep; upon its leveled top the next material is placed, and so on until all have been added like layers on a layer cake. Commencing at one end, the pile is shoveled over, reaching clear to the bottom every time. The pile is then leveled up and the operation repeated three times. The mixture may then be screened again if desired.

In this system a farmer has a definite knowledge of the kinds of plant food that he purchases. Each ingredient can be examined separately and its nature and quality determined. "Leather, shoddy, wool waste, or other inferior materials can not be palmed off as readily as when disguised by other materials in mixed goods."

A further advantage is the ability of the farmer to vary the proportions of the different fertilizing ingredients to suit the varying requirements of soil and crop. It has been urged in objection to this that the farmer as a rule does not possess the information necessary to enable him to mix his fertilizing ingredients in the proper proportions to meet most economically the varying requirements of his soils and crops.

If the farmer does not know the requirements of his own soil who is to tell him? No two soils have exactly the same needs and no two crops the same requirements. It is idle to hope that some "special" fertilizers can be compounded which will be perfectly adapted to a given crop on all soils and under all conditions. This is a species of agricultural quackery which fortunately is rapidly passing away. It is becoming more and more evident every day that in the use of fertilizers, as in other agricultural operations, every farm is an experiment and that every farmer must be an alert experimenter. Each farm has its problems distinct from those of every other farm, and they can only be solved by patient study and experiment on the part of the farmer himself. No outsider can tell him just what to do and just what fertilizer to use in each particular case.

The farmer can no longer afford to use fertilizers blindly and solely on the statement of someone else. He must study the principles underlying the use of fertilizers and determine by experiment the kinds and amounts best suited to his own peculiar needs. The experiment stations organized in every State and Territory have always stood ready to direct and assist the farmer in this important work, and in doing this have performed one of their most useful functions.

To summarize briefly, it is believed that the investigations of the stations and the experience of practical farmers show that the main conditions which must be observed by intelligent and progressive farmers in order to make the system of home mixing of fertilizers entirely feasible and thoroughly economical are "(1) that the supplies should be purchased in considerable quantities, (2) that they should be purchased early and prepared before the beginning of the busy season on the farm, and (3) that contracts should be on a cash basis."

Potash, as a constituent of fertilizers, exists in a number of forms, but chiefly as chlorid or muriate and as sulphate. All forms are freely soluble in water, and are believed to be nearly if not quite equally available, but it has been found that the chlorids may injuriously affect the quality of tobacco, potatoes, and certain other crops. The chief sources of potash are the potash salts from Stassfurt, Germany—kainit, sylvanite, muriate of potash, sulphate of potash, and sulphate of potash and magnesia. Wood ashes and cotton-hull ashes are also sources of potash. The potash in them is in the form of carbonate.

Specific gravity of solid substances is the ratio of the weight of a given bulk of the body to that of an equal bulk of water, or, stated in another way, the ratio of the weight of the substance in air to its weight in water.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the bulletins named below are available for distribution:

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